

**A COMPARISON OF THE LARYNGEAL TUBE WITH
THE LARYNGEAL MASK AIRWAY DURING SPONTANEOUS
VENTILATION IN PAEDIATRIC ANAESTHESIA**

TABLE OF CONTENTS

ACKNOWLEDGEMENT

ABSTRAK

ABSTRACT

TABLE OF CONTENTS

LIST OF PICTURES/TABLES

LIST OF FIGURES

ABBREVIATIONS

1. INTRODUCTION

2. OBJECTIVES AND DEFINITION

3. LITERATURE REVIEW

3.1 LARYNGEAL TUBE (VBM)

3.1.1 History

3.1.2 Characteristics of the laryngeal tube (VBM)

3.1.2(a) Size selection

3.1.2(b) Cuff volumes and pressure

3.1.3 Indications to laryngeal tube (VBM) use

3.1.4 Contraindications to laryngeal tube (VBM) use

3.1.5 Advantages of laryngeal tube (VBM)

3.1.6 Performance tests

3.1.7 Insertion and Removal of laryngeal tube (VBM)

3.1.8 Caring for laryngeal tube (VBM)

3.2 LARYNGEAL MASK AIRWAY

3.2.1 History and Development of the laryngeal mask

3.2.2 components of the Laryngeal Mask

3.2.3 Indications to laryngeal mask use

3.2.4 Contraindications to laryngeal mask use

3.2.5 Advantages and Disadvantages of laryngeal mask

3.2.6 Advantages of laryngeal tube (VBM) over laryngeal mask

3.2.7 Insertion and removal of laryngeal mask

3.2.8 Caring for laryngeal mask

3.2.9 Complications after laryngeal mask removal

3.2.9 (a) Coughing/Bucking

3.2.9 (b) laryngospasm

3.2.9 (c) sorethroat

3.2.9 (d) dysphonia

3.2.9 (e) aspiration

3.2.9 (f) vocal cord paralysis

4. METHODOLOGY

5. RESULTS

5.1 DEMOGRAPHIC DATA

5.1.1 Age

5.1.2 Weight

5.1.3 Height

5.1.4 Gender

- 5.1.5 ASA (American Society of Anesthesiologists)
 - 5.1.6 Duration of anesthesia, surgery and emergence
- 5.2 TIME TO SUCCESSFUL INSERTION
- 5.3 NUMBER OF INSERTION ATTEMPTS TO SECURE AIRWAY
- 5.4 AIRWAY TRAUMA
- 5.5 AIRWAY MANIPULATION AND ETCO₂
- 5.6 HAEMODYNAMIC DATA
- 6. DISCUSSION
- 7. CONCLUSION
- 8. BIBLIOGRAPHY
- 9. APPENDIX

1. INTRODUCTION

Many patients undergoing general anaesthesia do not require endotracheal intubation. Previously airway management in spontaneously ventilating patients for short elective procedures has been managed by use of facemask and laryngeal mask airway. The laryngeal tube (VBM, Medizintechnik GmbH, Germany) is a new airway device recently introduced into clinical practice. The design is based on the oesophageal obturator airway and it is designed to be inserted blindly into the oesophagus. The laryngeal tube consists of an airway tube with a small cuff at the tip (distal cuff) and a larger cuff in the middle of the tube (proximal cuff). The two low-pressure cuffs are inflated through a single pilot tube and balloon. The transmission of gases between the airway tube and the larynx takes place via a ventilation outlet, two openings which lie between these two cuffs. When the device is inserted, it lies along the length of the tongue and the distal tip is positioned in the hypopharynx. The proximal cuff stabilizes the tube in the oropharynx and the distal cuff seals the oesophageal inlet. At the proximal end of the tube there is a thick black line in the center where when correctly positioned lies at the level of upper incisor teeth. There are two thinner lines above and below the thick line which indicates the range of depth where the tube can be repositioned to allow sufficient ventilation. There is a standard 15 mm connector on the proximal end of the tube for attachment to a breathing system. There are six sizes of LT designated 0 to 5. Size 0 to 3 are used in paediatric anaesthesia.

The first case report regarding the use of laryngeal tube (LT) in adult patients was published in 1999. Since then studies have been conducted in mannequins to evaluate its use in emergency airway management. Following that further studies were conducted in anaesthetized adult patients during intermittent positive pressure ventilation as well as spontaneous ventilation. Three studies have been published so far to evaluate the use of laryngeal tube in paediatric anaesthesia. (Richebe et al, 2001, Gaitini et al. and Genzwuerker et al, 2003) and demonstrated encouraging results. A study by Zairul et al, 2003 on adult patients found that during spontaneous ventilation under anaesthesia the laryngeal tube form a suitable alternative to the laryngeal mask airway. Hence in this study we propose to compare the efficacy of the laryngeal tube with that of the laryngeal mask airway in paediatric patients breathing spontaneously under general anaesthesia.

2. OBJECTIVES AND DEFINITIONS

2.1 OBJECTIVES

- (i) To compare the easiness of insertion between laryngeal tube and laryngeal mask airway
- (ii) To compare the quality of ventilation between laryngeal tube and laryngeal mask airway
- (iii) To compare the haemodynamic parameters between laryngeal tube and laryngeal mask airway at different time intervals
- (iv) To compare the incidence of complications between laryngeal tube and laryngeal mask airway

2.2 NULL HYPOTHESIS

There are no difference in easiness of insertion, quality of ventilation, haemodynamic parameters and incidence of complications between laryngeal tube and laryngeal mask airway during spontaneous ventilation in paediatric anaesthesia.

2.3 DEFINITIONS

- (i) Easiness of insertion is defined as less time taken to insert the airway and less number of attempts required for a successful first tidal lung volume
- (ii) Quality of ventilation is defined as number of further manipulations of device or patients after insertion to maintain sufficient ventilation and any episodes of desaturation throughout the procedure.
- (iii) Hemodynamic parameters are defined as measurement of systolic blood pressure, diastolic blood pressure, mean arterial pressure and heart rate at different time intervals
- (iv) Complications are defined as intra and postoperative unfavorable effects like laryngospasm, airway trauma (blood on airway device), vomiting and coughing

3. LITERATURE REVIEW

3.1 LARYNGEAL TUBE (VBM)

3.1.1 History

The laryngeal tube (VBM) was designed by Volker Bertram in Sulz, Germany. It received its US patent in November 1996. It was developed as a variant of the oesophageal obturator airway and is designed to be inserted blindly into the oesophagus. The laryngeal tube (VBM) is an alternative to ventilation with face mask, laryngeal mask or for procedures where tracheal intubation is not necessary.

The first case report regarding the use of laryngeal tube (VBM) was published in 1999. Since then, many studies have been conducted to evaluate its role in emergency airway management out of hospital resuscitation and to secure a patent airway during spontaneous and controlled ventilation during general anaesthesia. It has also been tested for use in paediatric patients under anaesthesia and shown encouraging results. It is now commercially available for clinical practice.

3.1.2 Characteristics of the laryngeal tube (VBM)

The laryngeal tube (VBM) is a reusable curved shaped, single lumen, latex free, and silicone tube with two low-pressure cuffs connected to a single pilot balloon. The proximal (pharyngeal) cuff stabilizes the tube and blocks the naso and oropharynx. The oesophageal cuff when inflated blocks the entry of oesophagus hence reduces possibility of gastric ventilation and aspiration. Due to the short tube and S-shape, a blind insertion is possible without any instruments and it causes no irritation of vocal cords and trachea. The aperture between the two cuffs provides the route for ventilation. This ventilation hole lies in front of the larynx for efficient ventilation and it allows suctioning and bronchoscopy with fibroscope.

There are three markings called teeth marks on the proximal end of the tube, which provides a visual indicator to the user as to the final position after insertion. The thick middle line is for orientation and if necessary the laryngeal tube can be repositioned between the two thinner lines to allow sufficient ventilation. There is a standard colour-coded 15 mm connector on the proximal end of the tube for immediate identification of different sizes and for attachment to a breathing system.

3.1.3 (a) Size selection

Six sizes are now available ranging from size 0 to size 5 with specific colour-coded connector. Choosing the correct size of the tube depends on the patient's height and weight. For newborn less than 6 kilogram, the appropriate size is size 0, size 1 is for infant from 6 to 15 kilogram and size 2 is for children from 15 to 30 kilogram. Size 3 to 5 depends on the patient's height. Size 3 is used for teenager and small adult up to 155 centimeter, size 4 is for height between 155 centimeter to 180 centimeter and size 5 is for adult more than 180 centimeters.

Table 3.1: Sizes of laryngeal tube (VBM) in relation to patients' weight and height

Size	Patient	Weight/height	Color code connector
0	Newborn	Less than 6 kilogram	Transparent
1	Infant	6-15 kilogram	White
2	Child	15-30 kilogram	Green
3	Adult, small	Less than 155 centimeter	Yellow
4	Adult, medium	155-180 centimeter	Red
5	Adult, large	More than 180 centimeter	Purple

In 3 previous studies done on paediatric patients undergoing anaesthesia, the investigators use the laryngeal tube based on the weight, as per manufacturer's instruction. No studies have been done to correlate the height with the size used. Gaitini LA et al., 2001 in their study on 20 children found that 60% of the children were adequately ventilated with the LT size according to the manufacturer recommendations. In 40% of patients satisfactory ventilation was obtained only after replacing the initial LT size with a size superior than that recommended.

There are six colour-coded connector which determined the size of the laryngeal tube. The transparent connector for size 0, white connector for size 1, green connector for size 2, yellow connector for size 3, red connector for size 4 and purple connector for size 5.

3.1.2 (b) Cuff volumes and pressure

Both cuffs are high volume cuffs and are connected to a single pilot balloon. Both cuffs are inflated to 60-70 cmH₂O pressures using the pressure gauge manometer as recommended by manufacturer. If a cuff pressure gauge is not available the cuffs may

also be inflated by mean of a syringe which is provided with the laryngeal tube (VBM) package.

A study by Genzwuerker HV et al., 2003 demonstrated that with mean cuff pressure of 68.0(60-100) cmH₂O, auscultation over the stomach was negative in all their paediatric patients. The mean tidal volume was 191.9 ml during controlled mechanical ventilation resulting in a peak airway pressure of 15.9 cmH₂O. An earlier study by Richebe P et al. on 70 children demonstrated gastric ventilation in 13% of their cases with the average cuff inflation pressure of 63 cmH₂O.

Table 3.2: Size of the laryngeal tube (VBM) in relation to volume and pressure needed to inflate the cuff

Size	Cuff volume (ml)	Cuff pressure (cmH ₂ O)
0	10	60-70
1	20	60-70
2	35	60-70
3	60	60-70
4	80	60-70
5	90	60-70

3.1.3 Indications to laryngeal tube (VBM) use

The laryngeal tube (VBM) is now used for short elective surgical procedures under spontaneous or positive pressure ventilation. It is an alternative to face mask, laryngeal mask airway and endo-tracheal tube for fasted patients or those considered to have a low risk of aspiration of gastric contents. It has also been used in emergency conditions such as in pre hospital emergency use, during the management of difficult or failed airway and as a means to secure an immediate airway in cardiopulmonary resuscitation (CPR).

3.1.4 Contraindications to laryngeal tube (VBM) use

- (i). Patient who is at risk for pulmonary aspiration of gastric contents such as morbidly obese, history of gastro-oesophageal reflux and full stomach patient.
- (ii) Patients with obstructed upper airways
- (iii) Procedures of long duration (more than 2 hours)

3.1.5 Advantages of laryngeal tube (VBM)

(i) Anaesthetist convenience

The insertion of laryngeal tube is easy with no special technique required (minimal learning curve). The device can be easily inserted either in extended or neutral head position and requires minimal mouth opening during insertion. A study by Genzwuerker et al., Oct 2003 on 57 paediatric patients showed that LT was placed successfully in 55 patients (96.5%) with 90.9% during first attempt and 9.1% during second attempt. Richebe P. et al found that the head was maintained in extension to make the insertion easier in 83% of cases using size 0, 30% in children using size 2 and 3 and for maintenance of anaesthesia position required was neutral for more than 85% of patients. Harald V. Genzwurker, 2000 conducted a study on 50 physicians and nurses and he found that during 500 insertions of the laryngeal tubes (VBM), correct placement and sufficient ventilation were achieved 478 times in first attempt (95.6%).

Another study by Asai et al., 2002 on the efficacy of the laryngeal tube by inexperienced personnel found that the insertion of the laryngeal tube was easier than the insertion of the laryngeal mask airway, therefore they decided that the laryngeal tube has a potential role in providing a clear airway during cardiopulmonary resuscitation.

The laryngeal tube (VBM) does not require maintenance, leaving the anaesthetists free to attend monitoring and record keeping (hands-free)

(ii) Patient safety and tolerance

The laryngeal tube (VBM) insertion is atraumatic and easy with minimal damage to the oropharyngeal structures and minimal incidence of sore throat compared to tracheal intubation. Genzwuerker et al., 2003 found minor traces of blood in 2 cases out of 57 paediatric patients studied. They also found that only one patient complained of mild sore throat post removal of LT. A study by Riechebe et al. on 70 paediatric patients also found the incidence of moderate postoperative pharyngeal pain in 1 patient.

The soft cuffs of the laryngeal tube (VBM) adjust better to the anatomy (patient comfort). The large proximal cuff stabilizes the laryngeal tube and patient can be moved without creating leaks. Asai et al., 2000 demonstrated that the distal cuff of the laryngeal tube provided a good seal towards the oesophagus and therefore a better protection against regurgitation. Genzwuerker et al, 2003 also found negative finding on the auscultation of stomach in all his paediatric patients.

In a study by Genzwuerker et al, 2003 on 57 boys undergoing anaesthesia, they found the incidence of laryngospasm in one case however sufficient ventilation was possible after deepening of anaesthesia. Richebe P et al. in their earlier study found the one incidence of stridor and 2 laryngospasm out of their 70 paediatric patients. However none of these children had incidence of oxygen desaturation.

(iii) Cost Effectiveness

The laryngeal tube (VBM) can be used on its own following induction of general anaesthesia, during maintenance and as a recovery airway until patient is fully awake, reducing the need for additional airway devices, e.g. oral airways, laryngoscopes, suction apparatus etc. The price is cheaper compared to laryngeal mask airway. The need for additional drugs, e.g. neuromuscular blocking agents is also minimized. The ease of insertion reduces the anaesthetic time with minimal risk of damage to the teeth, caps and crowns and therefore more comforting to the patient and the medico-legal budget of the hospital.

The laryngeal tube (VBM) is made from silicone (latex free) and is designed as a reusable device. With proper cleaning, sterilization and handling, the laryngeal tube may be expected to withstand repeated steam autoclaving at 134° C (273° F) up to 50 times. Continued use beyond 50 times is not recommended as degradation of the components may occur, resulting in impaired performance or abrupt failure of the device.

3.1.6 Performance tests

All of the non clinical tests described below must be conducted before each use of the device. Failure of any one test indicates that the device has passed its useful life and should be replaced.

(i) Visual Inspection

Examine the transparency of the airway tube. The device should not be used when there is discoloration of the airway tube as this impairs the ability to see and effectively remove foreign particles during cleaning or to see regurgitated fluids during use.

Examine the surface of the device for damage, including cuts, tears, or scratches. Do not use if the airway tube is damaged in any way. Examine the interior of the tube to ensure that it is free from blockages or loose particles. Flex the tube up to, but not beyond 180°; should the tube kink, the device should be discarded. Examine the 15 mm connector, it should fit tightly into the outer end of the airway tube, ensure that it cannot easily be pulled off by hand using reasonable force.

(ii) Inflation and Deflation

Insert syringe into the inflation line and fully deflate the cuffs so that the cuff walls are tightly flattened. Remove the syringe from the inflation line and cuff wall should remain deflated. Inflate the cuffs from complete vacuum to the recommended maximum inflation volume; leaking and deflation will be evident within 2 minute. Examine the symmetry of the inflated cuffs, there should be no uneven bulging seen. Finally examine the inflation pilot balloon, the balloon shape should be elliptical not spherical.

(iii) Pre-insertion Preparation

Prior to insertion of the laryngeal tube (VBM), evacuate the cuffs completely with the syringe so that they lie smoothly on the tube. Lubricate the cuffs with a water-soluble lubricant, such as K-Y jelly. Lubricants containing xylocaine are not recommended for use as xylocaine can delay the return of the patient's protective reflexes prior to removal of the device airway and preservatives used may also cause allergic reaction towards patients.

Insertion of the laryngeal tube (VBM) requires an anesthetic depth similar to that, which allows placement of an oropharyngeal airway. The optimal induction agent would produce jaw relaxation and attenuation of airway reflexes, allowing insertion within 30-60 seconds of loss of consciousness.

3.1.7 Insertion and Removal of laryngeal tube (VBM)

(i) Insertion (Figure 2.1)

Step 1- Hold the laryngeal tube like a pen in the area of the black teeth marks or at the connector. The head is either extended or in neutral position. Both cuffs have to be completely deflated and lubricated with before insertion.

Step 2- Insert the tip of the laryngeal tube against the hard palate; make sure that the tongue is not pushed back. In case of problems a lateral insertion might be useful. Slide the laryngeal tube smoothly along the midline of the mouth into the hypopharynx until the middle black line is level with the teeth.

Step 3- Inflate the cuffs with the Cuff Pressure Gauge to 60-70 cmH₂O. Both cuffs are inflated with only one inflation line. If in an emergency situation where no cuff pressure gauge is available, the cuffs can also be inflated by means of the included syringe (follow the inflation volumes in the instructions of use).

Step 4- The laryngeal tube (VBM) is now in place and the patient can be ventilated. Connect breathing circuit and check the lung ventilation by auscultation and chest movement. If ventilation is not sufficient reposition the tube to distal or proximal between the thin teeth marks. With the VBM bite block the Laryngeal tube can be protected and fixed safely. The internal ramp at the ventilation outlet will direct devices into the trachea such as fiber optic scope, tube exchanger and suction catheter.

(ii) Common problems with insertion

(a) Leak pressure more than airway pressure- measure the leak pressure and make sure that it is higher than the airway pressure to avoid gastric insufflation with its risk of regurgitation.

(b) Level of anesthesia- make sure that anaesthesia is deep enough to avoid airway closure. The laryngeal tube is a pharyngeal airway device, which is placed before the vocal cords. Too light anesthesia could result in closure of the vocal cords and airway obstruction.

(c) Insertion- lateral insertion can be useful in case of insertion problems. A study conducted by S. A. Khan et al., 2003 found a better method of laryngeal tube insertion with better success rate by aided anterior mandibular displacement or jaw thrust.

(iii) Removal of laryngeal tube (VBM)

The laryngeal tube (VBM) should be well tolerated until the return of protective reflexes. Onset of swallowing indicates reflexes are almost restored. Remove the laryngeal tube when patient is able to open mouth on command. Make sure that both cuffs are completely deflated before removal of the laryngeal tube.

3.1.8 Caring for laryngeal tube (VBM)

(i) Cleaning

Clean the laryngeal tube by thoroughly washing the cuffs and the tube with only soap and warm water or mild alkaline cleaning agents such as a diluted (8-10% w/w) sodium bicarbonate solution until all visible foreign matter is removed. Do not use germicides, disinfectants, or chemical agents such as glutaraldehyde (e.g. Cidex), ethylene oxide, phenol-based cleaners or iodine- containing cleaners for cleaning or sterilizing. Such substances are absorbed by device materials, resulting in exposure of the patient to unnecessary risk and possible deterioration of the device. Thoroughly rinse with water to eliminate all residues of the cleaning agents. Visibly check to ensure that no foreign matter is present.

b) Sterilization

Steam autoclaving at 134° C is the only recommended method of sterilization for laryngeal tube (VBM). Ensure that the tube is completely dry, inside and outside. Both cuffs must be completely evacuated prior to autoclaving using a syringe because any air or moisture left in the cuffs will expand at the high temperatures and low pressures of the autoclave, causing irreparable damage to the cuffs and/or pilot balloon. The laryngeal tube may be placed in an appropriate autoclave-proof bag. After autoclaving, allow to cool to room temperature before use.

3.2 LARYNGEAL MASK AIRWAY

3.2.1 History and Development of laryngeal mask airway

The development of the laryngeal mask airway began in 1981 at the Royal London Hospital, Whitechapel, in the East End of London by British anaesthesiologist, Professor Archie Brain. The prototype laryngeal mask airway was based on the modification of the Goldman Dental Mask. It was first used by Dr Brain on human patient in 1981 and was subsequently used successfully in a pilot study on 23 patients. In 1983, Dr Brain reported the first use of laryngeal mask airway in a failed intubation. It became commercially available in the United Kingdom in 1988 and was used in more than 500 British hospitals within first 12 months of its availability in the United Kingdom. In August 1991, it was approved as a substitute for the face mask during elective anaesthesia by the Food and Drug Administration of United States.

The laryngeal mask airway is a novel device that fills the gap in airway management between use of a facemask and tracheal intubation. (Brain AIJ, 1995). It is relatively simple to insert and have a role in management of the difficult or failed intubation.

When it was first invented, Dr Archie Brain raised the question, is there a better way to combine an anatomical airway and an artificial airway? The facemask falls short, stopping at the mouth and nares while the endotracheal tube goes too far into the trachea. The use of cuff in the ETT produces a high pressure to the smooth epithelial surface of the respiratory tree and may provoke undesirable autonomic responses. The laryngeal mask is simple to use, traumatic to insert, helpful in overcoming an obstructed airway and better fits the ideal connection between the anatomical and artificial airway. Since its introduction, the laryngeal mask airway has achieved increased popularity in paediatric practice. Its use is increasing in many clinical settings, especially day-case surgery and short procedures in which intubation is not necessary.

3.2.2 Components of the laryngeal mask airway

The LMA is made up of medical-grade silicone rubber that is latex free. This allows the LMA to withstand repeated autoclaving. The device has a shaft ranging from 5.25 to 12 mm in internal diameter, depending on the size of the LMA. The shaft is fused at a 30° angle to a distal elliptical spoon-shaped mask with an inflatable rim. The shaft is marked with a longitudinal black line along the posterior aspect, which gives a guide to the location of the spoon-shaped mask in the larynx. If the posterior black line is perpendicular to the middle of patient upper lips after insertion of the mask into the patient mouth, meaning that the mask is in the correct location in the larynx where the opening of the tube is facing the vocal cord.

The shaft opens into concavity of the ellipse via a fenestrated aperture with three orifices to prevent the epiglottis from falling back and blocking the lumen. The adequacy of the seal is dependent on the correct placement and appropriate size. It is less dependent on the cuff filling pressure.

The LMA also has an inflation pilot balloon with valve and inflation line. At the opening of the shaft (proximal end), there is a standard 15 mm connector that connects to a breathing circuit. A range of sizes are now available ranging from size 1 to size 6. To choose the appropriate size will depend on the patient's weight.

Currently, there are 8 sizes of the LMA available ranging from size 1 to size 6. Tham et al., 1994, suggested that the relationship with sex, weight, height and pharyngeal geometry in children was inconsistent when predicting the size of LMA. Ideally, the optimal LMA should be easy to insert, have an oropharyngeal leak pressure sufficient for positive pressure ventilation, a pharyngeal mucosal pressure less than capillary perfusion pressure and enable instruments to pass easily into the respiratory tracts.

3.2.3 Indications to laryngeal mask airway use

Laryngeal mask can be used in both children and adults. In operation theatre, it is mainly used in a well fasted patients undergoing short procedures. It has also been used in the management of the difficult or failed airway. In 1991, Benumof reviewed the difficult airway algorithm and included the laryngeal mask airway in the "cannot intubate and cannot ventilate" scenario. In prehospital care the LMA can be used when the patient is profoundly unconscious with loss of protective pharyngeal and laryngeal reflex and intubation is not possible due to restricted access or for other technical reasons. It has also been included in the European Cardiopulmonary Resuscitation algorithm on immediate airway management during CPR. Currently it is increasingly being used for pediatric and neonatal resuscitation.

3.2.4 Contraindications to laryngeal mask airway use

The primary contraindication to elective use of the LMA is a risk of gastric-content aspiration (e.g. full stomach, hiatus hernia with significant gastro esophageal reflux, morbid obesity, intestinal obstruction, delayed gastric emptying). Other contraindications include poor lung compliance or high airway resistance, glottic or subglottic airway obstruction and limited mouth opening (<1.5 mm).

3.2.5 Advantages and Disadvantages of laryngeal mask airway

(i) Advantages

- Ideal for elective outpatient/daycase procedures
- Can be used for spontaneously breathing patients as well as with assisted and controlled ventilation
- Not equipment invasive
- No muscle relaxant necessary
- Lower incidence of sore throat
- Reusable

- Latex free

(ii) Disadvantages

- No protection from gastric regurgitation
- Possibility of stomach insufflations at ventilation pressures higher than 20 cmH₂O
- Easy to torque out of position
- Expensive device
- Insertion requires experience and skill (learning curve)

3.2.6 Advantages of the Laryngeal Tube (VBM) over the Laryngeal Mask Airway

- Insertion of laryngeal tube (VBM) is easier with no special technique required (minimal learning curve)
- Laryngeal tube requires minimal mouth opening during insertion
- Minimal head movement during insertion with laryngeal tube, extended or neutral position
- Soft cuffs of the laryngeal tube adjust better to the anatomy (patient comfort)
- Distal cuff of laryngeal tube grants a good seal towards the esophagus and therefore a better protection against regurgitation.
- Reduced risk of gastric ventilation even with higher ventilation pressures compared to LMA (higher sealing pressure)
- Large proximal cuff stabilizes the laryngeal tube; patient can be moved without creating leaks
- Less airway trauma, no blood after laryngeal tube removal
- Lower incidence of sore throat when using laryngeal tube
- Bite block with elastic neck strap and syringe are included in the laryngeal tube (VBM) package (size 3, 4, 5)
- Price- cheaper than LMA

3.2.7 Laryngeal Mask Airway insertion and removal

(i) Insertion of laryngeal mask airway

The laryngeal mask airway is inserted blindly into the pharynx, forming a low-pressure seal around the laryngeal inlet and permitting gentle positive-pressure ventilation with the administration of inhaled anesthetics through a minimally stimulated airway. Dr Brain's initial contemplation of this laryngeal mask airway was to mimic the placement of food into the hypopharynx, hence establishing the placement of a device, which could then serve as an airway. Prototype insertion methods involved rotation through 180° and the early use of an introducer to prevent down folding of the epiglottis.

The current recommended technique was found to be less traumatic and have a 98% success rate. Although the insertion is relatively simple, proper attention to details will improve success rate. An ideally positioned cuff is bordered by the base of the tongue superiorly, the pyriform sinuses laterally and the upper oesophageal sphincter inferiorly (Morgan & Mikhail, 1992). The epiglottis often lies within the bowl of the mask but the device functions satisfactorily with the epiglottis in the upright horizontal or down folded position. Nandi et al., 1991 demonstrated radiological findings of epiglottis down folding in 66% of cases.

The Insertion of the laryngeal mask does not require laryngoscope. The mask is lubricated with a non- local anesthetic-containing lubricant and is fully deflated to form a thin, flat wedge shape

A variation on the insertion technique has been described in paediatric cases. There are many anatomical differences between paediatric and adults, which include relatively large tongue, higher and more anterior larynx and a more acute angle between the floor of the mouth and the pharyngeal lumen. Mc Nicol, 1991 inserted the device upside down with the laryngeal aperture pointing cephalad. As the laryngeal mask entered the pharynx, it was rotated through 180°. Other maneuvers to aid in insertion include slight inflation of the cuff, a jaw thrust and by using laryngoscope.

(ii) Removal of the laryngeal mask airway

Removal of the LMA should be done once the patient is awake and can open the mouth on command. (Brain AJ, 1991). If this route is chosen, use of a bite block is recommended to avoid the common complication of attempted biting on the LMA. The laryngeal mask cuff protects the larynx from pharyngeal secretions hence reducing the risk of inducing laryngospasm. Onset of swallowing indicates reflexes are almost restored. Brain has stated previously that it is best to leave the cuff inflated until the mask is ejected spontaneously. Usually suction is unnecessary because correctly used LMA protects the larynx from oral secretions.

3.2.8 Caring for the laryngeal mask airway

(i) Cleaning

The LMA should be thoroughly washed with mixture of warm water and diluted sodium bicarbonate solution until all visible foreign matter is removed. The device should be cleaned using a small soft bristle brush. The cuff and airway tube are thoroughly rinsed in warm flowing tap water to remove cleaning residues. Carefully inspect the device to ensure that all visible matter has been removed.

(ii) Sterilization

Steam autoclaving is the recommended method for sterilization of the LMA. Prior to it, the cuff must be fully deflated and dry. After autoclaving, allow the LMA to cool to room temperature before use.

3.2.9 Complications after laryngeal mask airway removal

Many authors agree that children have an increased incidence of airway complications when recovering from anaesthesia compared with the adult population. Parry et al, 1997 conducted a prospective audit on the recovery phase of anaesthesia with the LMA in paediatric patients and they found that 90% of the children had a totally uneventful recovery period with no airway complications. In those cases where complications occurred, the commonest problem was either coughing or retching followed by laryngospasm. They found no episodes of aspiration or loss of airway.

3.2.9(a) Coughing/bucking

Coughing is the most common complication seen after LMA removal. Bucking is a more forceful and often protracted cough that physiologically mimics a valsalva maneuver. Coughing and bucking are not only unpleasant but can also be harmful. They can cause abrupt increases in intracranial and intraocular pressures. The increased intrathoracic pressure will decrease the venous return to the right atrium. Mason et al., 1990 studied the use of LMA in 200 paediatric patients and found that the incidence of coughing to be highest on the list followed by biting, laryngospasm, retching and vomiting.

3.2.9 (b) Laryngospasm

Laryngospasm is a protective reflex, involves reflex closure of the glottis by adduction of the true or false cords. It can be life threatening when it occurs after airway removal. Stimulation of a variety of sites from the nasal mucosa to the diaphragm can evoke laryngospasm. Most commonly it is due to reaction to a foreign body or substance eg. blood or saliva near the glottis. Suzuki and Sasaki., 1977 found that laryngospasm is due to prolonged adduction of the vocal cords mediated via the superior laryngeal nerve and cricothyroid muscle. It has been suggested that laryngospasm can be prevented by removal of airway under deep anaesthesia while the laryngeal reflexes are depressed especially for patient with high risk for bronchospasm.

3.2.9(c) Sorethroat

Postoperative sore throat following anaesthesia with LMA is multifactorial. Its incidence can be influenced by the method of insertion, the depth of anaesthesia at the time of insertion, the correct size of LMA, the number of attempt at placement and the presence of humidified moist exchanger in the circuit.

3.2.9(d) Dysphonia

The LMA and LT do not transverse the vocal cord, hence the incidence of dysphonia is less than that induced by tracheal intubation. Nevertheless direct contact of the LMA with

the vocal cord and the arytenoid cartilage may occur in some cases and dysphonia may occur, albeit with varying incidence.

3.2.9(e) Aspiration

The overall incidence of regurgitation and aspiration with LMA is unknown. Brimacombe J, et al., 1994 found the incidence of aspiration with the LMA is 2.3 per 10,000 patients which is comparable to the facemask (2.6 per 10,000 patients) or tracheal tube (1.7 per 10,000 patients). A.I.J Brain, 1995 demonstrated that IPPV via LMA is not associated with a greater incidence of aspiration.

3.2.9(f) Vocal cord paralysis

Unilateral vocal cord paralysis may cause persistent hoarseness after extubation. Bilateral vocal cord paralysis may produce upper airway obstruction. Vocal cord paralysis is usually secondary to injury of the recurrent laryngeal nerve resulting in unopposed superior laryngeal nerve mediated adduction of the vocal cords.

Mechanisms proposed for vocal cord paralysis include misplacement of the LMA tip between the false vocal cords causing pressure on the vocal folds and lead to paresis, hyperextension of the neck resulting in stretching of vagus nerve, local diffusion of the lignocaine jelly applied to the LMA cuff, reaction to products used for cleaning and pressure neuropraxia by the over inflated cuff due to diffusion of nitrous oxide.

4. METHODOLOGY

After obtaining approval from the University research ethics committee and written informed consents from the parents, we studied 80 paediatric patients (ASA 1 or II, aged from 2-10 years) undergoing short elective surgery that did not require tracheal intubation. Exclusion criteria included patients at risk of pulmonary aspiration of gastric contents and those with features suggestive of possible difficult intubation.

This was a prospective randomized controlled trial. All children were fasted and received syrup promethazine 0.5mg/kg as premedication 1 hour prior to surgery. They were randomized to receive either a laryngeal tube or laryngeal mask airway by the use of sealed envelopes containing the letters LT or LMA. In the operation room, all patients received standard monitors such as electrocardiograph, pulse oxymeter, non-invasive blood pressure monitor, inspired oxygen and volatile agent analyzers.

General anaesthesia were induced identically in both groups by inhalational technique using sevoflurane 8% in Nitrous oxide/oxygen. Fentanyl $1.5 \mu\text{g.kg}^{-1}$ was given once intravenous access was obtained. The concentration of volatile agent will be reduced down to 3% when the child was no longer physically moving. The facemask was maintained for at least 1 minute. The LT or LMA will be inserted after adequate depth was achieved as assessed by loss of eyelash reflex, verbal response, jaw relaxation and absence of movement. The same investigator inserted the airways in all 80 patients.

In the LT group, the laryngeal tube was inserted based on the weight as recommended by the manufacturer's instruction manual. Size 0 for newborn up to 6 kg, size 1 for children from 6-15 kg, size 2 for children from 15-30 kg and size 3 for children above 30 kg. Before insertion both cuffs were deflated and lubricated with a water soluble lubricant (KY jelly) With the head extended on the neck, the tip of the LT was placed against the hard palate behind the upper incisors and the device was slid down in the center of the mouth until resistance was felt or the bold middle line had just passed between upper and lower teeth. The cuffs were inflated using a cuff pressure gauge manometer supplied by the manufacturer to the pressure of 60-70 cmH₂O.

In the LMA group, LMA size 2 was used for children from 6.5 kg up to 20 kg, size 2½ for 20-30 kg and size 3 for 30 kg upwards. The back of the cuff was lubricated with KY jelly and the mask was inserted by method described in the manufacturer's instruction booklet. The cuff was inflated with 10 ml of air for size 2, 14 ml for size 2½ and 20 ml for size 3.

In both groups, the breathing system was connected to the device. We assessed the adequacy of ventilation by observing the tracing of ETCO₂ waveforms and chest movement. After successful placement of LT or LMA anaesthesia was maintained with 2 to 3 MAC of sevoflurane and 66% nitrous oxide in oxygen. Ventilation will be manually assisted until respirations are regular. The end-tidal CO₂ was maintained between 45-65 mmHg. The children breathed spontaneously throughout the procedure and no muscle relaxant was administered. Intermittent fentanyl boluses were given intravenously if

analgesia was inadequate. Regional block such as caudal block was used as appropriate for pain relief.

When the insertion of LT or LMA was unsuccessful at first attempt, manipulations like jaw thrust or chin lift was done and further attempt was made. If it was not possible to ventilate the lungs or if ETCO₂ or chest movement did not indicate a patent airway, in case of LT, the position was adjusted by gently pushing or pulling the device and adequacy of ventilation was reassessed. (no such manoeuvre was allowed for LMA). If it was still not possible to insert or ventilate through the laryngeal tube or laryngeal mask after three attempts, it was recorded as a failure and the study was terminated. The airway was then secured in the most suitable manner determined by the attending anaesthetist.

After commencement of surgery, the patients were observed for any sign of partial or complete airway obstruction. If they were noted, airway manipulations (pushing the airway in or out to find the ideal position, further extension of the head, chin lift or jaw tilt) were used in attempt to clear the airway. Failing that the devices were removed and the airway was secured by other means.

Patients' demographic data was recorded which include age, sex, weight, height and ASA status. Duration of anaesthesia and duration of surgery were also recorded. The time to insert the airway device was taken, measured from removal of facemask to successful delivery of the first tidal lung volume. The number of attempts required to insert the airway device successfully was recorded. Any episodes of desaturation and intraoperative manipulation of the device or patient after initial insertion were recorded. The haemodynamic parameters (systolic blood pressure, diastolic blood pressure, mean arterial pressure and heart rate) were recorded prior to induction, 2 minutes after insertion of airway device, prior to surgical incision, 2 minutes after surgical incision and prior to airway removal. The end-tidal CO₂ were recorded after insertion of devices, prior to surgical incision, two minutes after incision and prior to removal of the devices.

At the end of surgery both airway devices were removed with the children fully awake. The emergence time was recorded as interval between switching off the volatile agent to eye opening or obeying verbal commands. At removal of airway device, the presence or absence of blood on the device was examined. Incidence of laryngospasm after airway insertion, during maintenance or during airway removal was recorded. Postoperative complications such as coughing and vomiting were assessed and recorded at the time of discharging the patient from recovery room. Postoperative analgesia was supplemented by suppository paracetamol or diclofenac if regional block was not given.

Results are presented as mean and standard deviation or median and percentile. The statistical package for the social science (SPSS) version 12.00 for windows was used in statistical analysis. The data from two groups were analysed using the independent t-test for continuous variables or the chi square test for categorical data. Haemodynamic data were analyzed using ANOVA for repeated measurements. Differences were considered statistically significant when $p < 0.05$.

5. RESULTS

A total of 80 paediatric patients who had undergone elective surgery under spontaneous ventilation were studied and randomly assigned into 2 groups. 40 patients used laryngeal tube (VBM) and another 40 patients used laryngeal mask airway as an airway device.

5.1 DEMOGRAPHIC DATA

5.1.1 AGE

The mean age of patients in group LT was 5.2 years with a SD of 2.6 and group LMA was 4.9 years with a SD of 2.7. There was no statistical difference between groups according to age ($p=0.537$) (Table 5.1)

5.1.2 WEIGHT

Mean weight for LT group was 16.4 kg with a SD of 5.13 and group LMA was 16.1 kg with a SD of 5.2. There was no statistical difference between groups according to weight ($p=0.786$) (Table 5.1)

5.1.3 HEIGHT

Mean height for LT group was 108.0 cm with a SD of 17.2 and group LMA was 108.2 cm with a SD of 14.7. There was no statistical difference between groups according to height ($p=0.967$). (Table 5.1)

5.1.4 DURATION OF ANESTHESIA, SURGERY AND EMERGENCE

The mean duration of anesthesia, surgery and emergence for LT group were 46.4 min with a SD of 16.9, 26.6 min with SD of 13.1 and 8.2 min with a SD of 3.1 respectively; group LMA were 49.9 min with a SD of 17.0, 32.8 min with SD of 16.0 and 6.7 min with a SD of 3.2. There were no significant statistical differences in duration of anesthesia, surgery and emergence between two groups of study ($p=0.360$, $p=0.062$ and $p=0.05$). (Table 5.1)

Table 5.1 Characteristics of patients, duration of anaesthesia, surgery and emergence time. Values are given as mean (SD).

Parameters	Group LT (n=40)	Group LMA (n=40)	p value
Age (years)	5.2 (2.6)	4.9 (2.7)	0.537

Weight (kg)	16.4 (5.13)	16.1 (5.2)	0.786
Height (cm)	108.0 (17.2)	108.2 (14.7)	0.967
Duration of anesthesia (min)	46.4 (16.9)	49.9 (17.0)	0.360
Duration of surgery (min)	26.6 (13.1)	32.8 (16.0)	0.062
Emergence time (min)	8.2 (3.1)	6.7 (3.2)	0.050

5.1.5 GENDER

For LT group, total number of male patients was 32 (80.0%) and female patients was 8 (20.0%). In LMA group male patients was 35 (87.5%) and female patients was 5 (12.5%) There was no significant difference in gender between two groups in this study. (p=0.363) (Table 5.2 and Figure 5.1)

5.1.6 ASA (American Society of Anaesthesiologist)

For LT group, total number of ASA I patient was 38 (95.0%) and ASA II was 2(5%). In LMA group, 36 patients (90%) were ASA I and 4 patients (10.0%) were ASA II. There was no significant statistical difference between two groups in this study (p= 0.396). (figure 5.2)

Table 5.2 Number of patients according to gender. Values are given as number(proportion)

	Group LT (n=40)	Group LMA (n=40)	p value
Gender (Male: Female)	32:8 (80:20)	35:5 (87.5:12.5)	0.363

Figure 5.1 Gender distributions in groups

Table 5.3 Number of patient according to ASA (American Society of Anesthesiologists) in the group. Values are given in number (proportion)

	Group LT (n=40)	Group LMA (n=40)	p value
ASA (I:II)	38:2(95:5)	36:4(90:10)	0.396

Figure 5.2 ASA distributions in group

5.2 TIME TO SUCCESSFUL INSERTION

The mean time to successful insertion for LT was 18.2 seconds with a SD of 6.2 , group LMA was 13.9 seconds with SD of 6.8. There was significant difference in time to successful insertion between the two groups (p=0.004). (Table 5.4)

5.3 NUMBER OF INSERTION ATTEMPTS TO SECURE AIRWAY

In group LT, 19(47.5%) of the patients had successful insertion with the first attempt, 14(35%) patients had two attempts and 7 (17.5%) patients had successful insertion after third attempts. For group LMA, 37(92.5%) patients had successful insertion with a single attempt and 3(7.5%) patients required two attempts for the insertion of LMA. There was significant difference in the number of attempts to secure airway between the two devices in this study (p =0.000) (Table 5.4 and Figure 5.3)

Table 5.4 Time to insertion of device and number of insertion attempts. Values are given as mean (SD) or number (proportion)

Parameters	⁴ Group LT (n=40) ²	Group LMA (n=40)	p value
Time to successful insertion (seconds)	18.2(6.2)	13.9(6.8)	0.004
Number of attempts 1 2 3	19(47.5) 14(35) 7(17.5)	37(92.5) 3(7.5)	0.000

Table 5.5 The incidence of intra operative airway manipulation. Values are given in number (proportion)

	Group LT (n=40)	Group LMA (n=40)	P value
37			
Intra operative airway manipulations (Yes: No)	35:5(87.5:12.5)	3:37(7.5:92.5)	0.000

Bar Chart

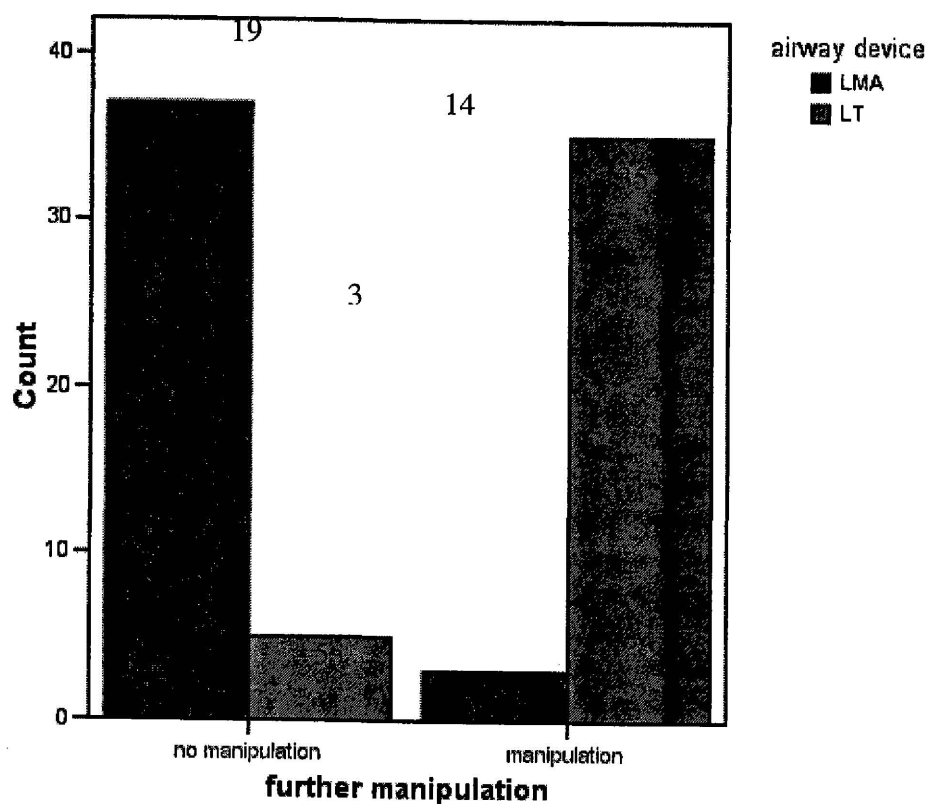


Figure 5.4 further manipulations of device or patients after first attempt

Table 5.6 The incidence of O₂ desaturations. Values are given in number (proportion)

	Group LT (n=40)	Group LMA (n=40)	P value
Episodes of O ₂ desaturations(Yes: No)	5:35(12.5:87.5)	2:38(5:95)	0.235

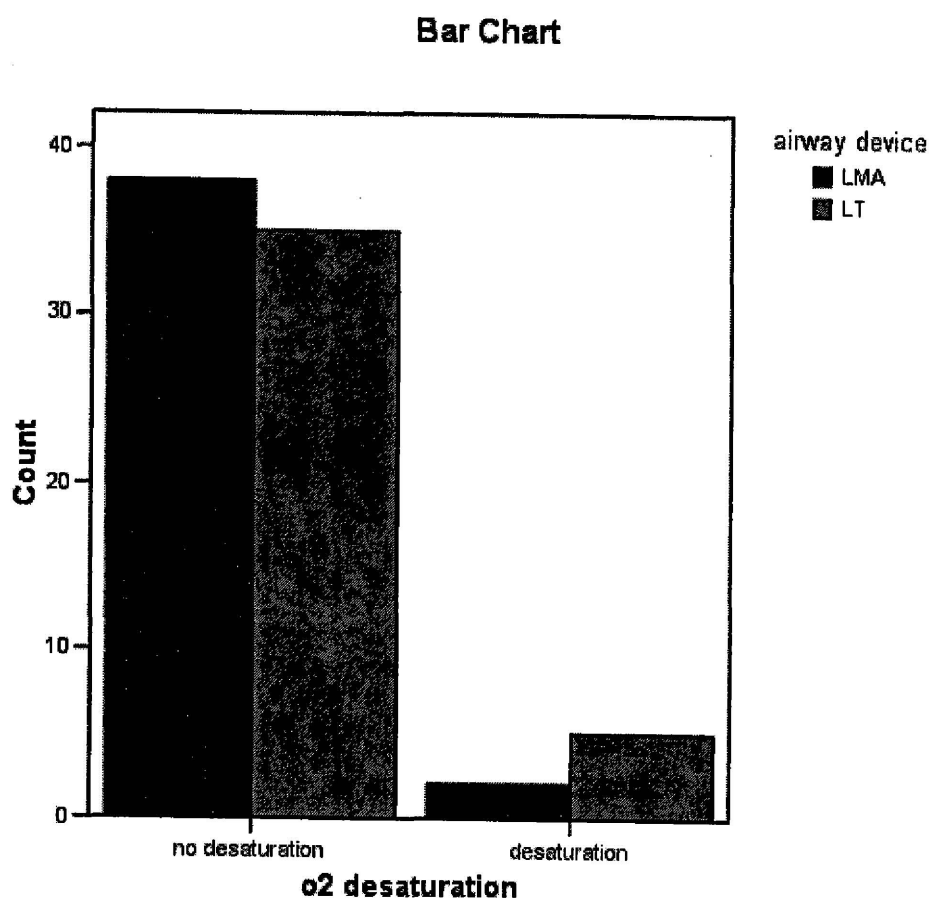


Figure 5.5: Episodes of O₂ desaturations (<95%)

5.4 AIRWAY MANIPULATION AND O₂ DESATURATIONS

The incidence of intra operative airway manipulations was significantly higher in the laryngeal tube group compared to laryngeal mask airway group with p value of 0.000

(Table 5.5). From 40 patients in LT group; 35(87.5%) of them required intra operative airway manipulations in order to maintain the airway patency and 5(12.5%) patients had episode of oxygen desaturation (<95%). In LMA group; only 3(7.5%) patients required airway manipulations during surgery with 2(5%) patients having episodes of desaturation. However there was no statistically significant difference in O₂ desaturations in LT group as compared to LMA group in this study.(p=0.235)

Table 5.7 End Tidal Carbon Dioxide (ETCO₂) at different time interval. Values are given in mean (SD).

Parameter		Group LT (n=40)	Group LMA (n=40)
Post airway insertion	ETCO ₂ (mmHg)	49.2(9.6)	49.1(7.0)
Pre surgical incision	ETCO ₂ (mmHg)	50.7(10.0)	49.1(7.3)
Post surgical incision	ETCO ₂ (mmHg)	51.4(10.5)	46.4(6.6)
Before anesthetic turned off	ETCO ₂ (mmHg)	54.4(8.8)	45.4(6.3)

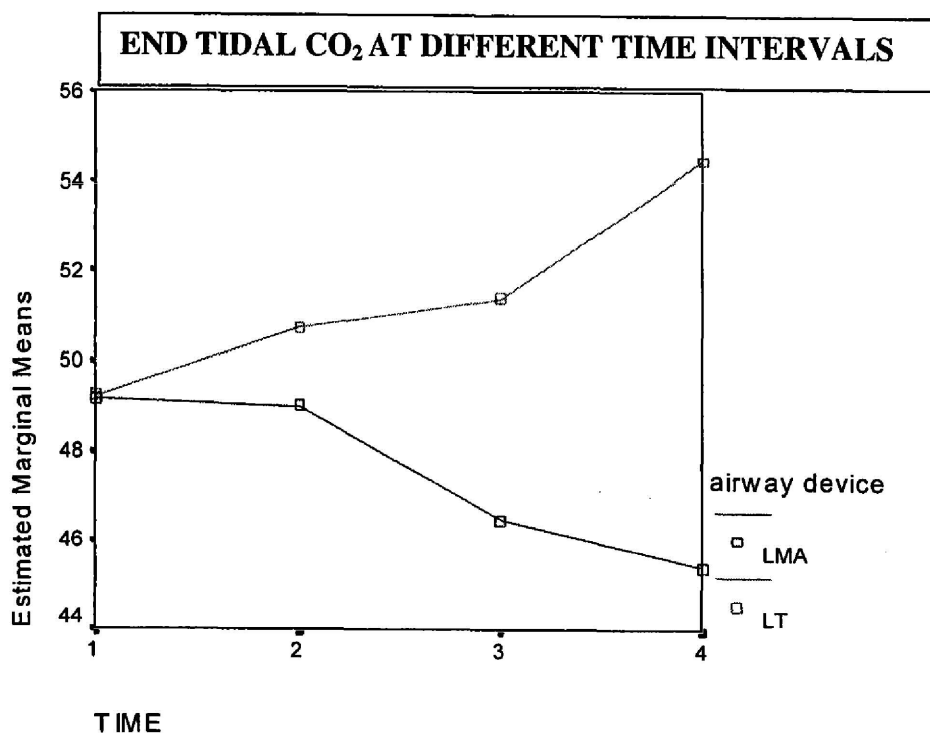


Figure 5. 6 End-tidal CO₂ at different time intervals

Key to timed events:

1. Post airway insertion
2. Pre surgical incision
3. Post surgical incision
4. Before anesthetic turned off

5.5 END TIDAL CARBON DIOXIDE (CO₂)

The end tidal CO₂ was significantly higher in the LT group compared to LMA group with p value of 0.012 using ANOVA for repeated measurement test.

Table 5.8 Haemodynamic Data (SBP and DBP). Values are given in mean (SD).

Parameter		Group LT	Group LMA
Before induction	SBP	91.4(9.4)	92.4(9.7)
	DBP	50.1(7.8)	52.7(9.4)
After induction & prior to insertion	SBP	85.0(9.9)	87.5(10.4)
	DBP	47.0(8.2)	48.5(7.1)

2 mins after insertion	SBP	89.6(11.1)	87.2(11.2)
	DBP	48.6(9.8)	46.4(8.4)
Prior to surgical incision	SBP	88.9(11.9)	87.3(9.2)
	DBP	47.9(10.7)	46.5(5.5)
2 mins after incision	SBP	95.3(11.9)	90.7(11.0)
	DBP	52.2(9.5)	49.0(8.8)
Prior to airway removal	SBP	95.6(9.9)	92.9(12.1)
	DBP	51.5(8.4)	51.4(11.1)

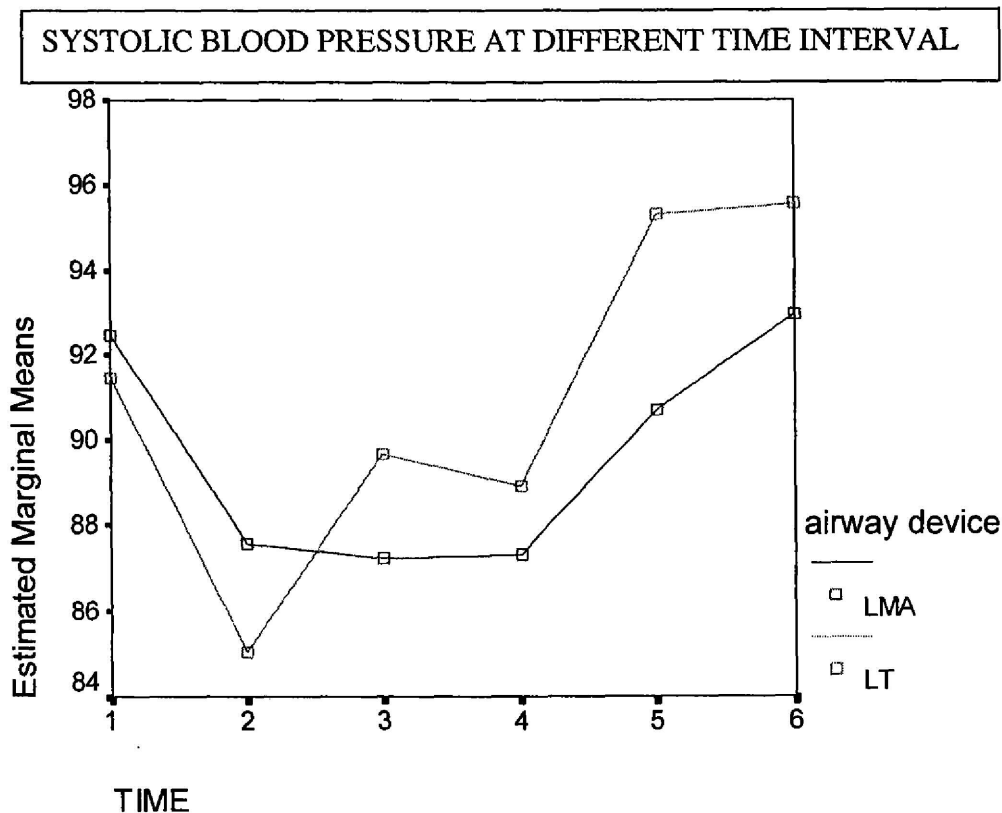


Figure 5.7: Systolic blood pressures (SBP) at different time intervals.

Key to timed events:

1. Before induction
2. After induction and before insertion
3. 2 minutes after insertion
4. Prior to surgical incision
5. 2 minutes after surgical incision
6. Prior to removal of airway

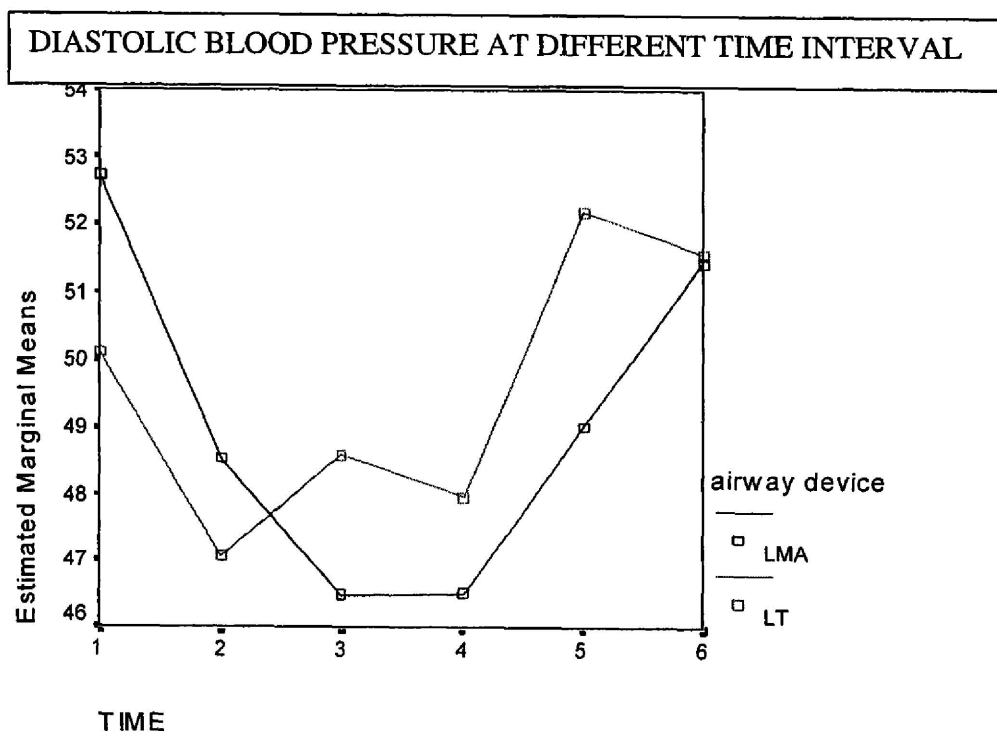


Figure 5.8 Diastolic blood pressures (DBP) at different time intervals.

Key to timed events:

1. Before induction
2. After induction and before insertion
3. 2 minutes after insertion
4. Prior to surgical incision
5. 2 minutes after surgical incision
6. Prior to removal of airway

Table 5.9 Haemodynamic data (MAP and HR). Values are given in mean (SD).

Parameter		Group LT	Group LMA
Before induction	MAP	64.3(8.1)	66.1(10.7)
	HR	97.4(16.3)	102.8(19.1)
After induction& prior to insertion	MAP	61.0(8.1)	62.0(8.9)
	HR	100.6(17.3)	100.3(16.2)
2 mins after insertion	MAP	62.3(10.3)	60.5(9.3)
	HR	101.3(19.3)	103.1(16.5)
Prior to surgical incision	MAP	62.4(10.6)	61.2(7.1)
	HR	101.4(18.4)	101.8(16.0)
2 mins after incision	MAP	67.6(9.4)	64.1(9.9)
	HR	106.8(17.3)	106.2(16.4)
	MAP	66.2(9.4)	66.4(13.1)

Prior to airway removal	MAP	66.2(9.4)	66.4(13.1)
	HR	109.8(18.0)	106.8(16.3)

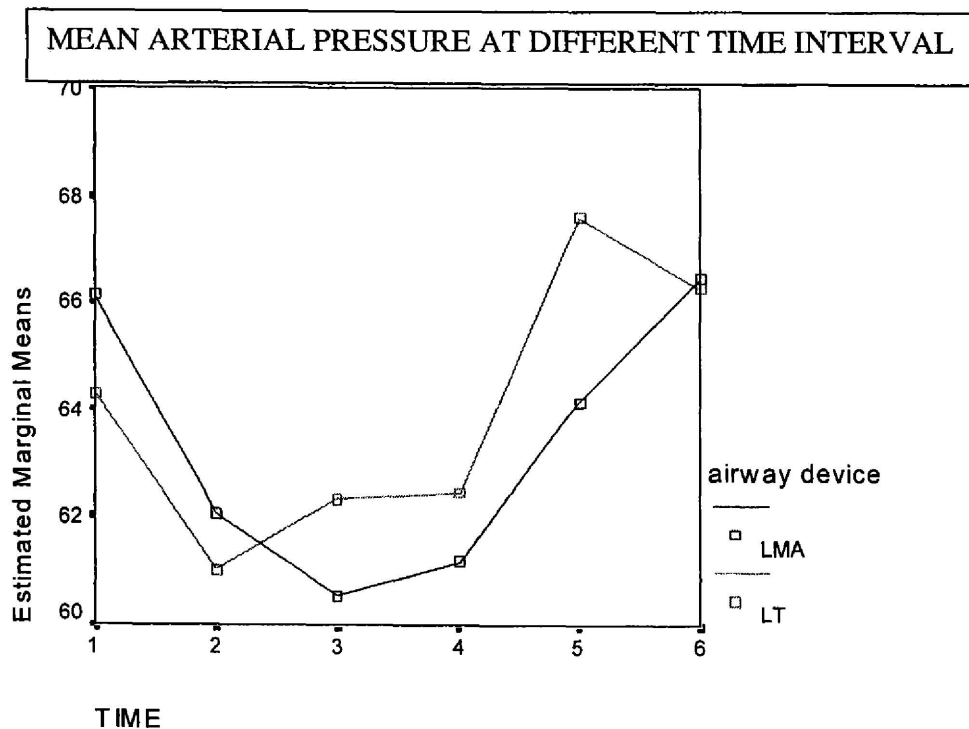


Figure 5.9 Mean arterial pressures (MAP) at different time intervals

Key to timed events:

1. Before induction
2. After induction and before insertion
3. 2 minutes after insertion
4. Prior to surgical incision
5. 2 minutes after surgical incision
6. Prior to removal of airway

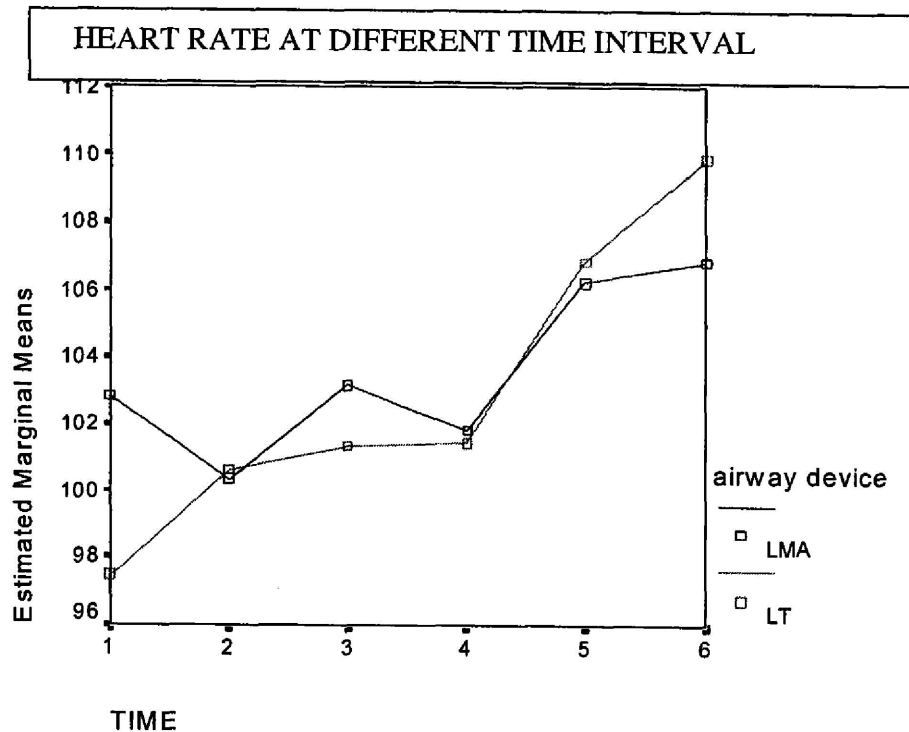


Figure 5.10 Heart rate (HR) at different time intervals

Key to timed events:

1. Before induction
2. After induction and before insertion
3. 2 minutes after insertion
4. Prior to surgical incision
5. 2 minutes after surgical incision
6. Prior to removal of airway

5.6 HAEMODYNAMIC DATA

The haemodynamic data i.e. SBP, DBP, MAP and HR is shown in Table 5.8 and Table 5.9; with pattern of haemodynamic changes depicted in graphs in Figure 5.7, Figure 5.8, Figure 5.9 and Figure 5.10.

Based on overall statistical analysis (ANOVA for repeated measurements), there were no significant statistical differences in the mean systolic blood pressure, mean diastolic blood pressure, mean arterial pressure and heart rate between the two groups with p values of 0.503, 0.735, 0.691 and 0.859 respectively.

Table 5.10 Incidence of intraoperative and postoperative complications. Values are given in number(proportion)

	Group LT (n=40)	Group LMA (n=40)	p value
Airway trauma (Blood on device) (yes:no)	0:40(0:100)	1:39(2.5:97.5)	0.314
Laryngospasm (yes: no)	1:39(2.5:97.5)	0:40(0:100)	0.314
Coughing(yes: no)	12:28(30:70)	12:28(30:70)	1.000
Vomiting(yes: no)	1:39(2.5:97.5)	4:36(10:90)	0.166

Analysis

There were no statistical differences between the two groups on presence of airway trauma(blood on airway device), laryngospasm, coughing and vomiting

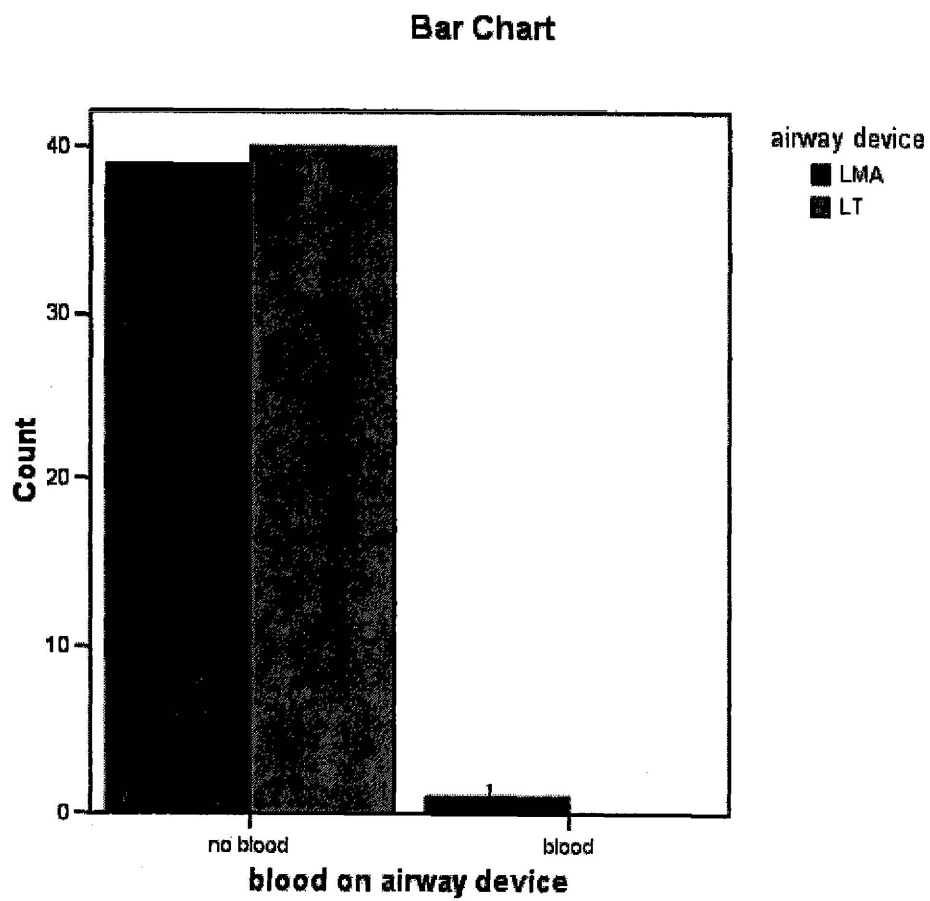


Figure 5.11 :Incidence of airway trauma (blood on airway device)

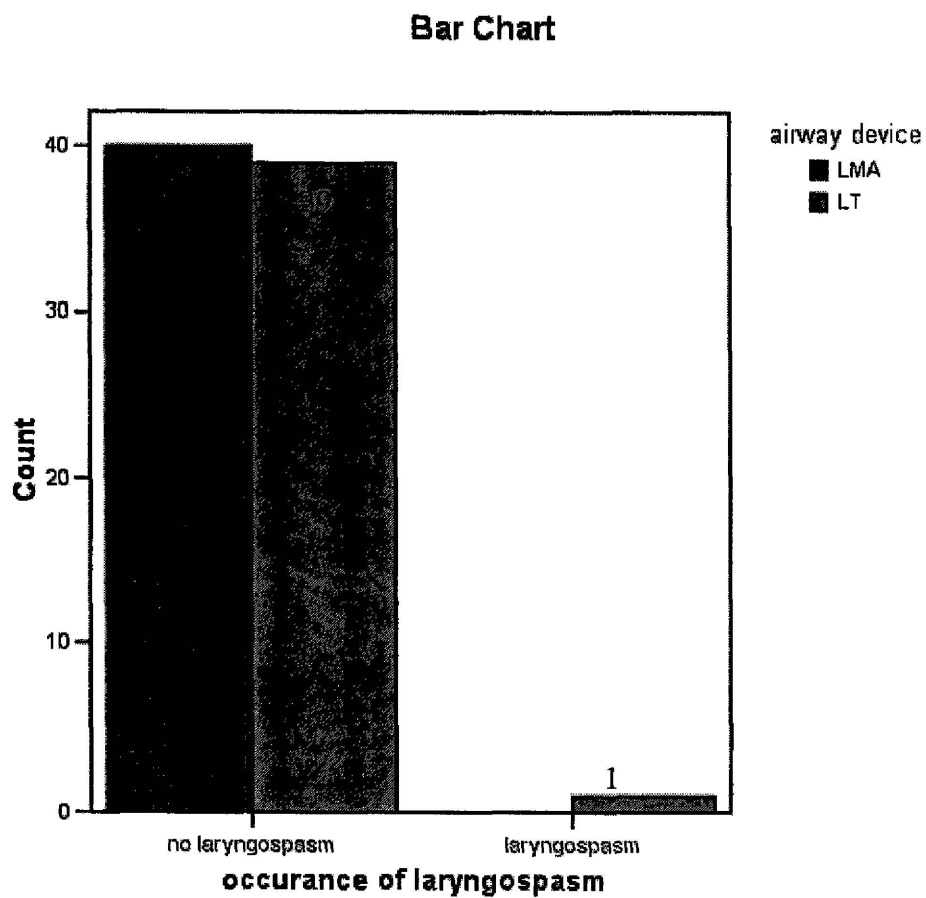
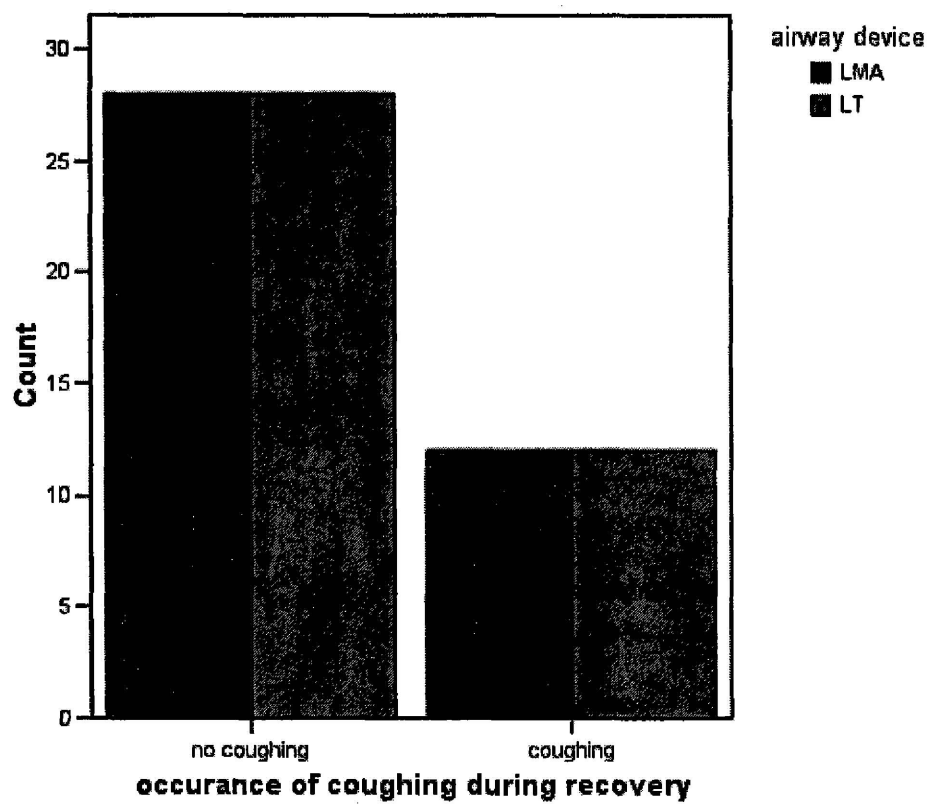


Figure 5.12: Incidence of laryngospasm

Bar Chart



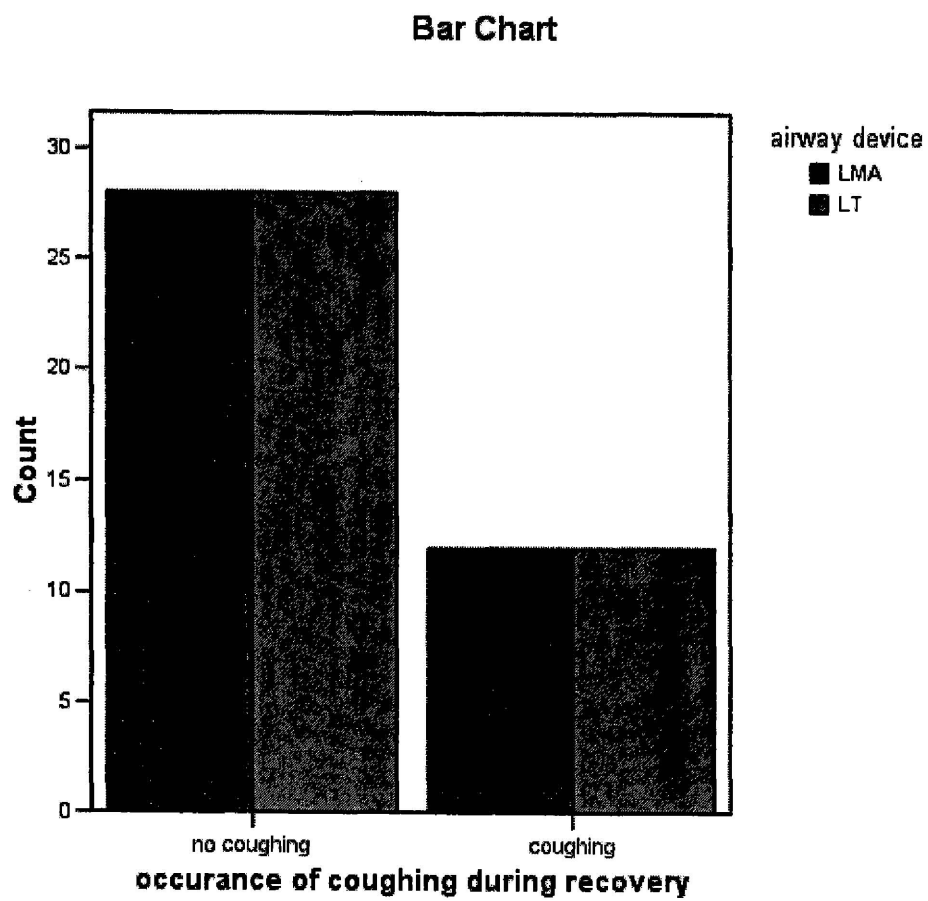


Figure 5.13 Incidence of coughing during recovery

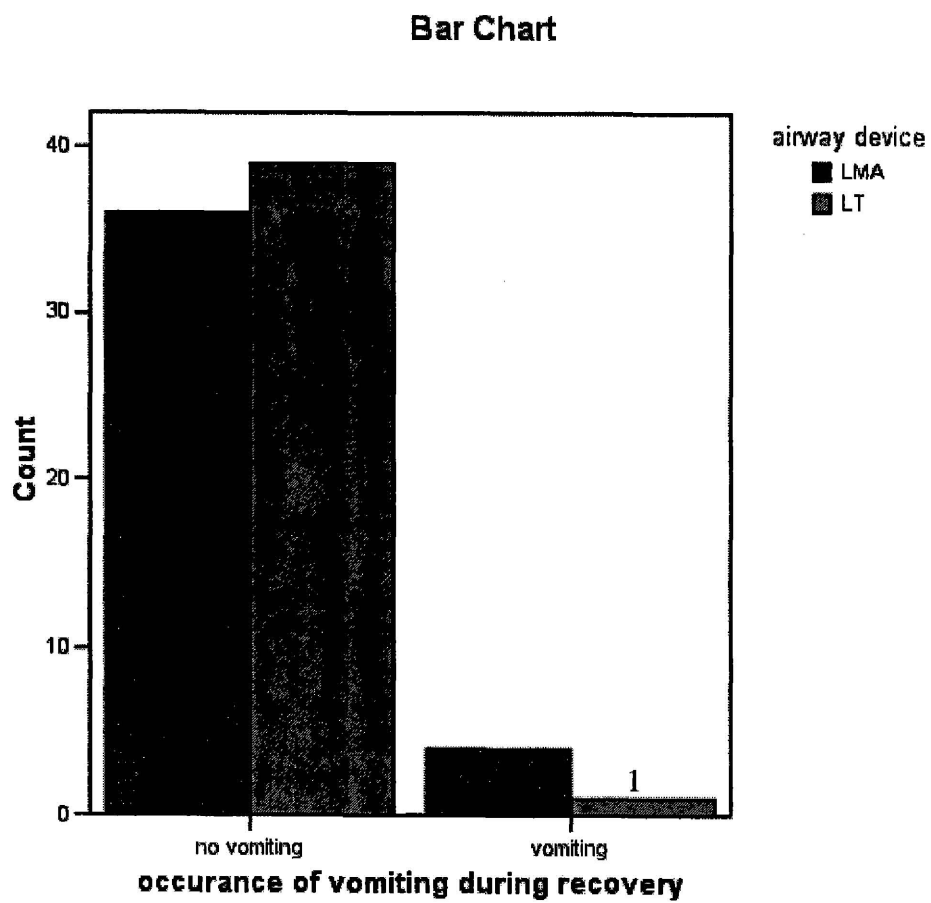


Figure 5.14: Incidence of vomiting during recovery

6. DISCUSSION

Very few studies on the use of laryngeal tube have been done on paediatric patients.

In this study we tested the use of laryngeal tube as an airway device in spontaneously breathing paediatric patients under anaesthesia comparing it to the laryngeal mask airway. The mean time taken to successfully insert the airway was 18.2 ± 6.2 seconds. In LMA group, the mean time required for successful insertion was 13.9 ± 6.8 seconds. The difference was statistically significant with $p = 0.004$. In LT group, 47.5% of the patients had successful insertion with one attempt, 35% with two attempts and 17.5% with third attempts. In LMA group 92.5% of patients had one attempt and 7.5% required two attempts. The difference was statistically significant with $p = 0.000$. Even though the time taken to insert the LT and the number of attempts required were more in LT group, the success rate of insertion was 100%.

Richebe P et al. studied 70 ASA 1 children and evaluate the easiness of insertion and they found that the number of attempts were more than two for 67% of children using size 0, 15% for size 2 and 19% for size 3. Genzwuerker HV et al, 2003 did a study on 57 boys and found that the LT was placed successfully in 96.5% with 90.9% during first attempt and 9.1% during second attempt. He found the average time for insertion of LT was 11.8 seconds.

Richebe P et al found that additional manipulations (jaw thrust, chin lift or lingual traction) was necessary for 100% of size 0, 51% of size 2 and 23% of size 3. Genzwuerker HV et al, 2003 found 19.3% of patients required minor manipulation (chin lift) for adequate ventilation. Previous study by Chiu et al, 2003 comparing the use of modified laryngeal tube to laryngeal mask airway during spontaneous ventilation in adult patients found that the laryngeal tube required more insertion attempts and was associated with a higher incidence of airway obstruction needing airway manipulation when compared with laryngeal mask airway.

In our study, we found that the incidence of intra operative airway manipulations was significantly higher in the laryngeal tube group compared to laryngeal mask airway group with p value of 0.000. From 40 patients in LT group, 35 (87.5%) of them required further manipulation of the airways or patients after the first attempt in order to maintain adequate ventilation and 5 (12.5%) patients had episodes of oxygen desaturation ($<95\%$). In LMA group; only 3 (7.5%) patients required airway manipulations during surgery with 2 (5%) patients having episodes of desaturation. However there was no statistically significance difference in O_2 desaturations in LT group as compared to LMA group in this study. ($p=0.235$).

In our study, we use the patients' weight to determine the appropriate size of the laryngeal tube as outlined in the manufacturer's instruction booklet. In the study done by Asai et al, 2000 he found that when the LT size was decided based on the weight, ventilation was often inadequate in patients whose heights were less than 155 centimeter. They proposed that patient height might be more appropriate determinant when choosing the size of the laryngeal tube because the distance between the teeth and the oesophageal

inlet would correlate more with the height than with the weight. These factor may contribute to the high incidence of partial airway obstruction needing further manipulation in our study.

In our study, the same investigator inserted all the laryngeal tubes and the laryngeal mask airway to eliminate user bias. We saw no evidence that the efficacy of the laryngeal tube changed as the study progressed and our observation was loss of airway control during surgery became more frequent towards the end of the trial.

In our study we also noted that in LT group, on occasion, manual ventilation of lungs was successful despite a subsequent need for airway manipulation to overcome the problems. This is in agreement with Miller et al., 2001 who postulated that the burden of the increased work of breathing in partial airway of obstruction was easily overcome by manual ventilation, but not as easily by a patient's respiratory effort. During spontaneous breathing this increase in work of breathing by the patient may result in increased CO₂ production and less CO₂ elimination.

We found that the end tidal carbon dioxide was significantly higher in LT group compared to LMA group at all four timed intervals with p value of 0.012. Although various airway manipulations appeared to successfully overcome airway obstruction in the LT group, the ETCO₂ remained higher. We also noted that the ETCO₂ in the LT group increased as the surgery progressed. Hence special precaution must be taken, if we want to use it in patient who may encounter harmful effect of high end tidal CO₂.

The mechanisms to explain higher end tidal CO₂ level with higher incidence of a airway manipulations has been postulated by Miller et al., 2001 where he postulated that it may be due to the effect of nitrous oxide that diffused into the cuffs which then lead to a rise in pressure and further inflation of the cuffs . As it does so, if it is slightly below or above the middle of the cricopharyngeus sphincter, it may pull the device inwards or push it further out. If it pulls inwards, the anterior aperture in the laryngeal tube may be obstructed in upper esophagus. If it moves in the outward direction, the lower cuff may become obstructive to the laryngeal opening.

In our opinion, the size of the laryngeal tube also plays an important role in order to avoid the airway obstruction and it seems with a proper size selection may reduce the incidence of airway obstruction. If a smaller size laryngeal tube is used, the distal cuff may not be seated properly at the side and once the cuff is inflated it will obstruct the laryngeal opening. Inflation of lower cuff at improper place may cause the epiglottis to fold downwards and to close against the glottis. Again in LT group, if a smaller or inappropriate size been selected, it could end up with the esophageal or oronasopharynx not fully sealed by both cuffs and because of the instability and with the effect of nitrous oxide that been used intraoperatively, it may lead outward migration of the tube which can caused obstruction to the ventilation holes and finally lead to airway obstruction.

A study on haemodynamic responses while using LT and LMA under spontaneous breathing anesthesia on adult patients was reported by C. L. Chiu and colleagues, 2003.

Their study involved a total of sixty patients revealed no significance statistical difference in haemodynamic responses for both LT group and LMA group. A study done by Zairul et al, 2003 concluded that LT was as effective as LMA in maintaining the haemodynamic responses to insertion . A reduced haemodynamic effect response may be beneficial in patients with cardiovascular and cerebral disease.

In our study, we found that there was overall reduction in systolic ,mean and diastolic blood pressure after induction, possibly due to vasodilatory effects of inhalational agent used, sevoflurane. However there were no significant statistical differences in the mean systolic blood pressure, mean diastolic blood pressure, mean arterial pressure and heart rate between the two groups with p values of 0.503, 0.735, 0.691 and 0.859 respectively.

Many investigators agree that children have an increased incidence of airway complications when recovering from anaesthesia. Richebe P et al., found the incidence of laryngospasm in two out of 70 paediatric patients studied but no patient had episodes of desaturation (<95%). Genzwuerker HV, 2003 reported one case of laryngospasm out of 57 boys studied .We also encountered the same problem in the LT group where one patient (2.5%) developed laryngospasm but we were able to maintain sufficient ventilation after deepening of anaesthesia. No such incidence occurred in LMA group. However the difference between these two groups was not statistically significant, $p=0.314$.

Genzwuerker HV et al, 2003 found minor traces of blood on the LT in two cases out of 57 boys undergoing spontaneous ventilation. We studied the incidence of airway trauma in both groups by presence of blood on airway devices used during extubation at the end of surgery. We found that the incidence of airway trauma was not significantly different between the two groups in this study with the p value of 0.314. We did not find any incidence of airway trauma in LT group whereas 1(2.5%) patient had blood on the device in the LMA group. This finding did not correlate with the more number of attempts made in the LT group. The tip of the laryngeal tube (VBM) was made of soft silicone in order to minimize oropharyngeal injury and these advantages could explain the possible reason for the finding in our study. From this study we can conclude that the laryngeal tube (VBM) offered an equivalent safety to laryngeal mask airway as atraumatic airway device.

Richebe P et al, in his study on 70 children using LT reported the incidence of coughing in 6 cases. In our study we found the incidence of coughing to be equivalent in LT and LMA group that is 12 patients (30%) in each group. Statistically the difference was not significant.

Study by Zairul et al, 2003 found that none of their 121 adult patients complained of nausea and vomiting. Their study had used propofol as an induction agent, which is known to have antiemetic effect. Our study revealed 1(2.5%) patient to have vomiting in the recovery period while LMA group had 4 (10%) patients with episodes of coughing. However the difference was not statistically significant with p value of 0.166.

7. CONCLUSIONS

In summary, we compared the use of laryngeal tube (VBM) and laryngeal mask airway during spontaneous ventilation in paediatric anaesthesia and measured the easiness of insertion, quality of ventilation, haemodynamic responses to insertion of these devices and the incidence of intraoperative and postoperative complications. There were statistically significant difference in measurement of easiness of insertion and quality of ventilation in terms of significant airway or patient manipulation intraoperatively. Regarding the haemodynamic responses to insertion and intraoperative as well as postoperative incidents, the laryngeal tube is a valuable but no better alternative to the laryngeal mask airway. Based on all our findings, we conclude that during spontaneous ventilation in Paediatric Anaesthesia, the laryngeal tube is not as reliable in providing a satisfactory airway and we consider it is not a suitable alternative to the laryngeal mask airway.

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9. APPENDIX

DATA SHEET FOR STUDY

1.DEMOGRAPHICS

Name _____
Registration number _____
Age _____
Sex Male Female
Weight _____
Height _____
ASA Status _____
Procedure _____

2.INTRAOPERATIVE DATA

Airway type LMA LT Size _____

Time to secure airway _____

Number of attempts to secure airway _____

Further manipulation of device or patients after first attempt _____

Episodes of oxygen desaturation (<95%) _____

	ETCO2
Post airway insertion	
Presurgical incision	
Post surgical incision	
Before anaesthetic turned off	

	SBP	DBP	MAP	HR
Prior to induction				
After induction and prior to airway insertion				
2 mins after airway insertion				
Prior to surgical incision				
2 mins after surgical incision				
Prior to airway removal				

Emergence time(spontaneous eye opening after anaesthetics turned off)

Blood on airway device _____

Occurrence of laryngospasm _____

Duration of surgery _____

Duration of Anaesthesia _____

3.RECOVERY DATA

Occurrence of coughing _____

Occurrence of vomiting _____